

# Mercury Control by EPRI MerCAP™ Process

NETL Mercury Control Technology Conference  
December 13, 2006

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# Presentation Outline

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- **Host Site 1**
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  - **Discussion of recent work and final results**
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# Project Background

- **Financial Assistance Program DE-FC26-03NT41993**
- **Two Test Sites**
  - **Georgia Power Plant Yates Unit 1**
  - **Great River Energy Stanton Station Unit 10**

# Project Team



**Pierina Noceti  
(COR)**

**Bill Aljoe**



**Juliana Kyle  
Ken McBee  
Mark Berry**



**Steve Smokey  
Mark Strohfus**

# URS

**Carl Richardson  
Tom Machalek**



**Tim Ebner  
Kevin Fisher  
Rick Slye  
Trevor Ley**



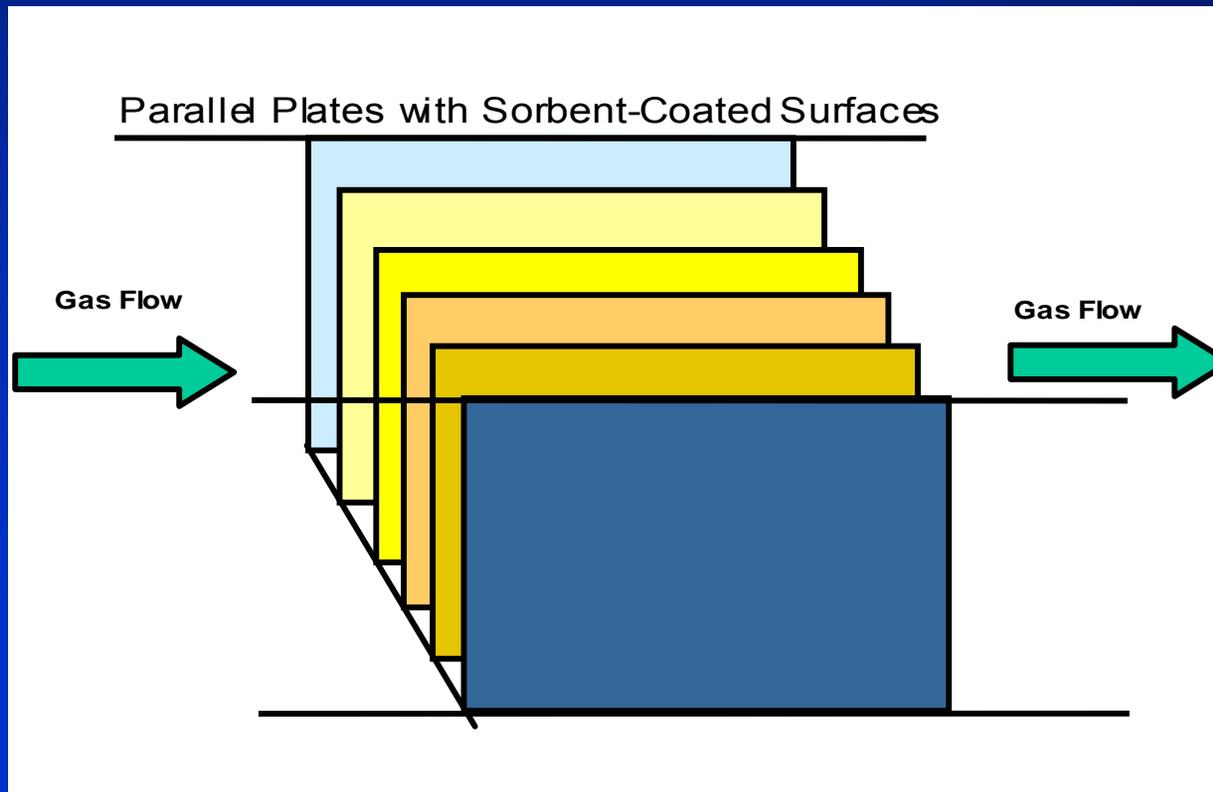
**Ramsay Chang**



**Sharon Sjostrom**

# Project Background

- Fixed sorbent structures to adsorb mercury
  - **Gold substrates**



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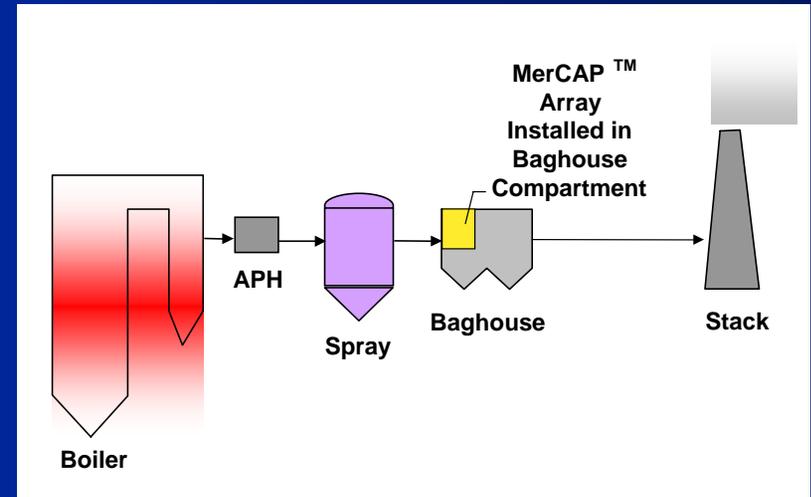
# Project Background

- Concept tested using small-scale probes since 1999
- Full scale tests at two sites downstream of scrubbers
  - **Plant Yates Unit 1 (on-going)**
    - 1 MWe slipstream fitted with gold plates
    - Wet Scrubber (Chiyoda CT-121 jet bubbling reactor)
  - **Stanton Unit 10 (completed)**
    - Full-scale baghouse compartment retrofitted with gold plates
    - Dry Scrubber

# Project Objectives

## Evaluate MerCAP™ technology downstream of wet and dry scrubbers

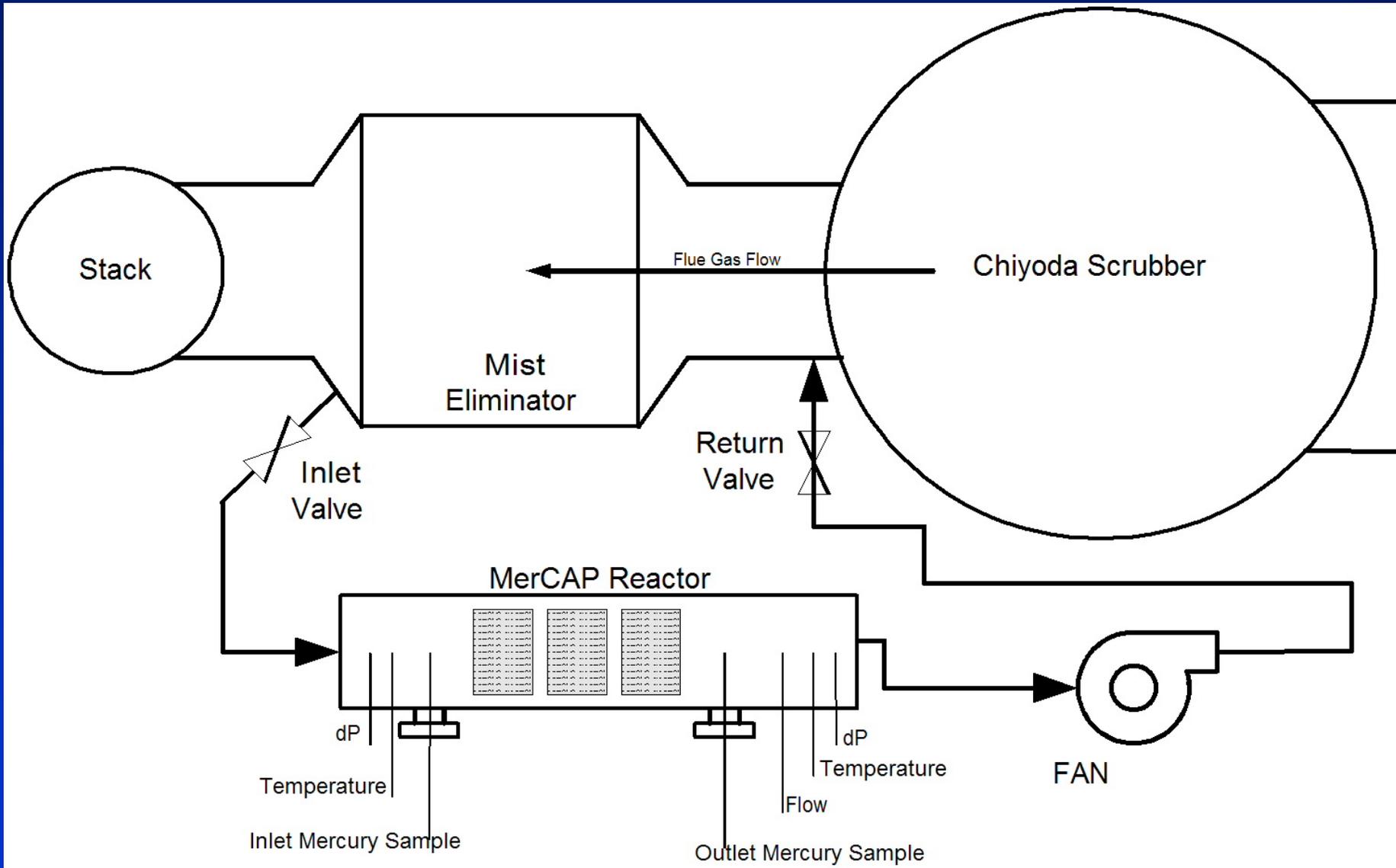
- Removal performance & variability
  - Optimal process conditions
- Regeneration
  - Thermal
  - Chemical
- Economic viability



# Georgia Power Plant Yates Unit 1

<b>Boiler</b>	
Type	<b>CE Tangential Fired</b>
Nameplate (MW)	<b>100</b>
<b>Coal</b>	
Type	<b>Eastern Bituminous</b>
Sulfur (wt %, day)	<b>1.0</b>
Mercury (mg/kg, dry)	<b>0.10</b>
Chloride (mg/kg, dry)	<b>300-1400</b>
<b>ESP</b>	
Type	<b>Cold-Side</b>
<b>SCRUBBER</b>	
Type	<b>Chiyoda CT-121</b>
Scrubber Outlet Temp. (°F)	<b>130</b>
<b>NO<sub>x</sub> Controls</b>	<b>Low NO<sub>x</sub> Burners</b>
<b>SO<sub>2</sub> Controls</b>	<b>Chiyoda CT-121 wet scrubber</b>

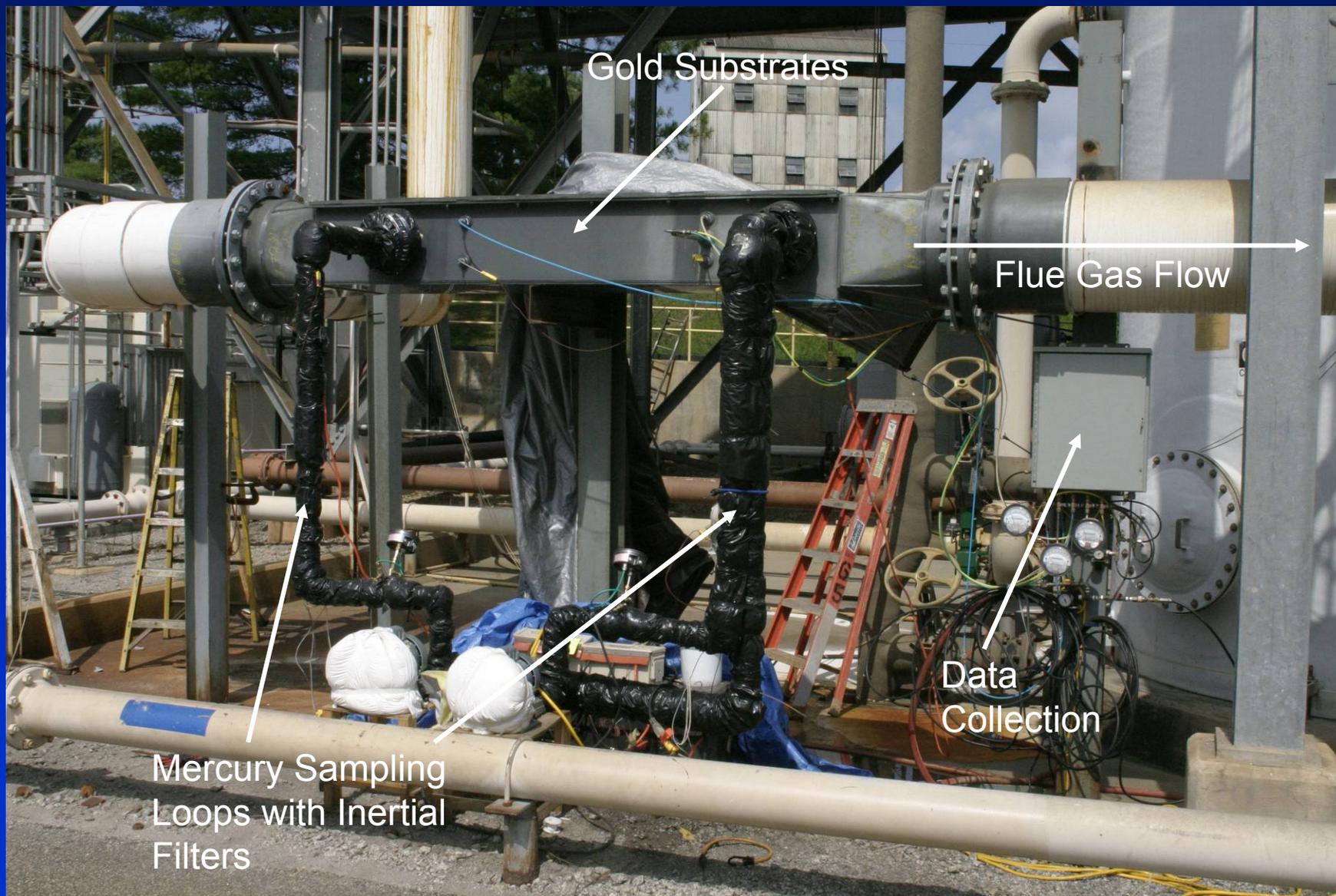
# Plant Yates Unit 1 MerCAP™ Configuration



# MerCAP™ Installed at Plant Yates Unit 1



# MerCAP™ Reactor



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# Planned Tests

## ■ Baseline Monitoring

- Determine Effects (if any) of reactor housing on mercury

## ■ Monitoring with gold substrates

- Initial testing after installation
- 6 months continuous operation
- Mercury measurements approximately every 40 days

## ■ Substrate Regeneration

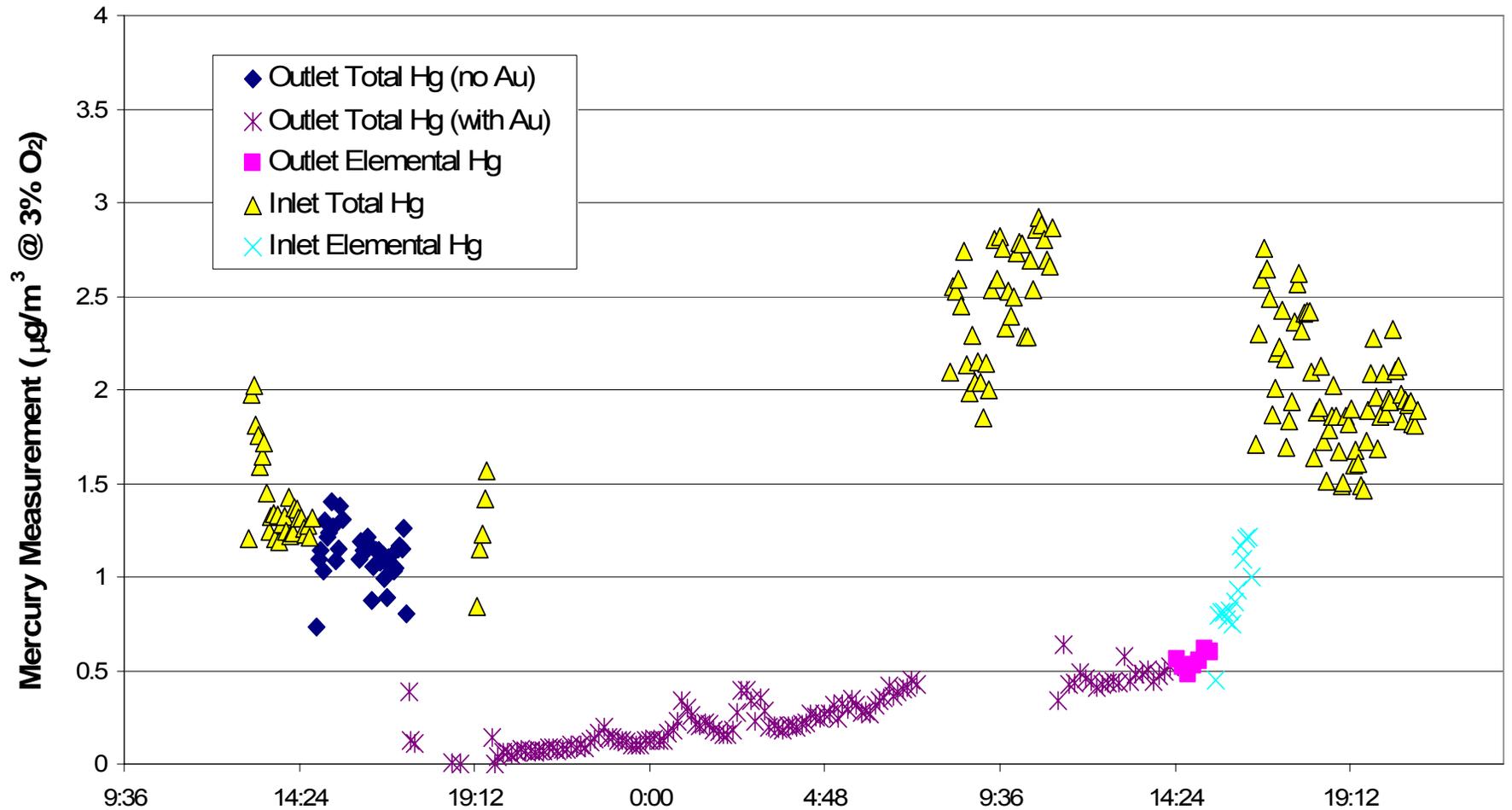
- Thermal
- Chemical (acid rinse)

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# Project Status – Plant Yates

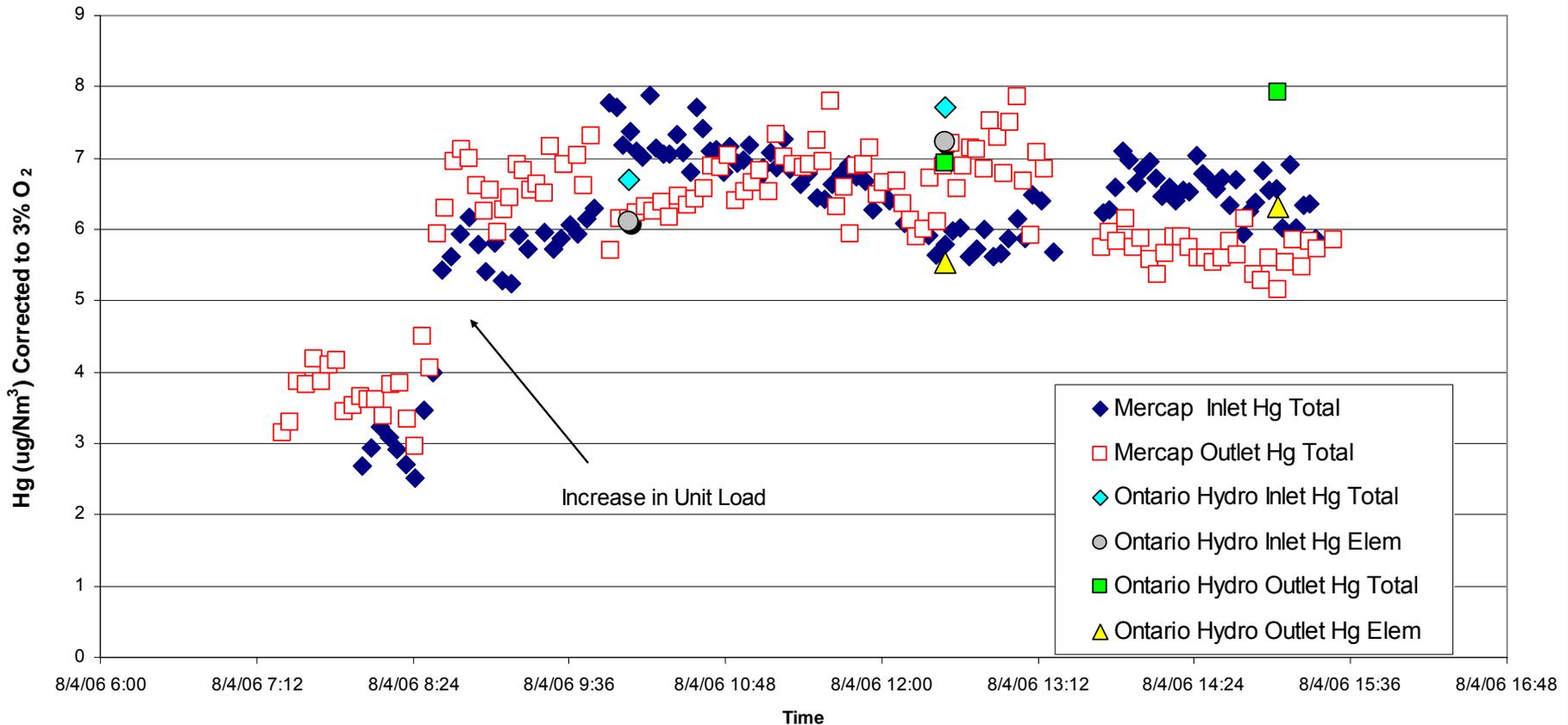
- **Baseline Monitoring**
  - **No effect of reactor housing on mercury**
- **Initial Mercury Measurements**
  - **Showed high mercury removal possible**
- **Fan Failure**
  - **Acidic Flue Gas backed up through system**
  - **Corroded substrates**
- **System re-routed to avoid high pressure drop**
  - **Substrates replaced and restarted July 2006**
- **6 months continuous operation w/new substrates**
  - **Planned Parametric tests**
    - **Wash frequency**
    - **Flue gas flow rate / mass transfer**

# Initial Results (Original Substrates)

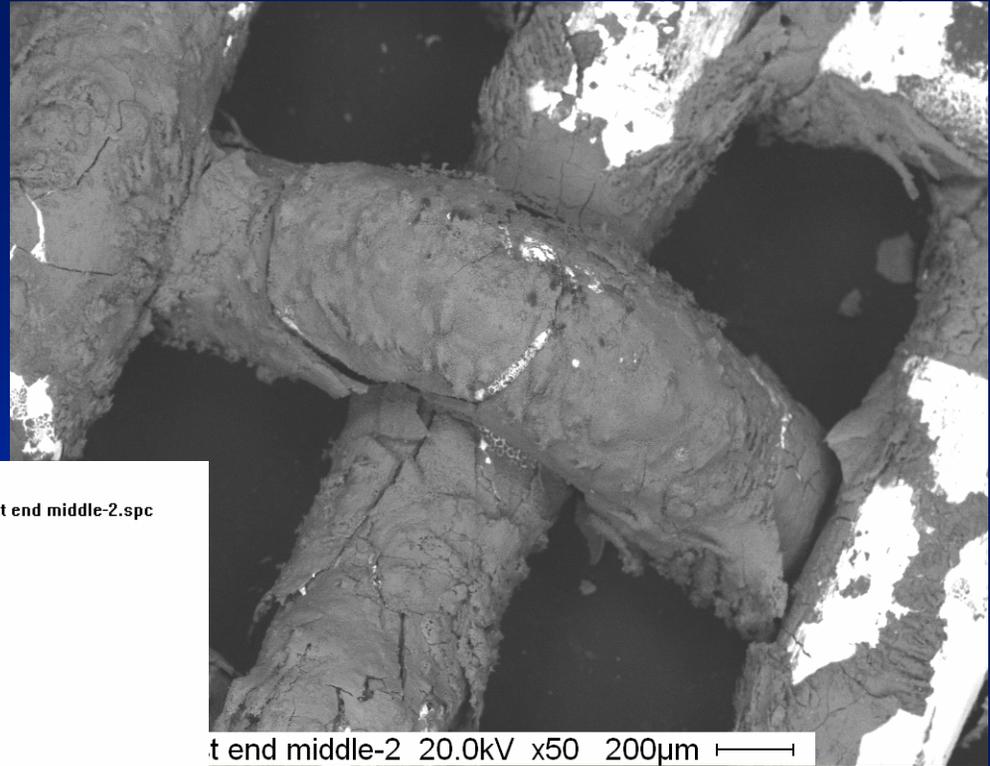


# Results (New Substrates)

Yates MerCAP™ Mercury Measurements - SCEM and Ontario Hydro  
520 Hours of Service

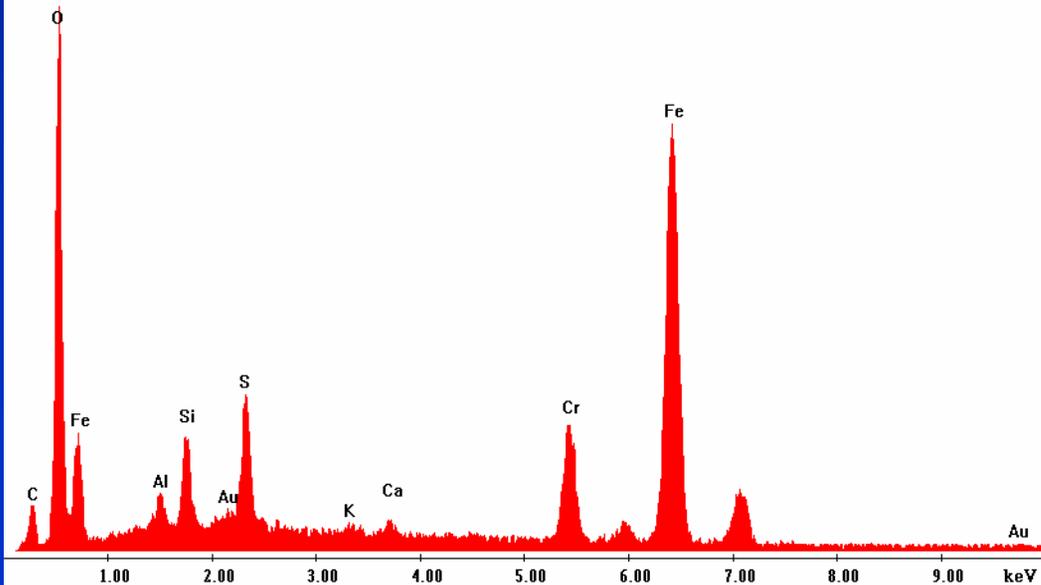


# SEM Analysis with EDS

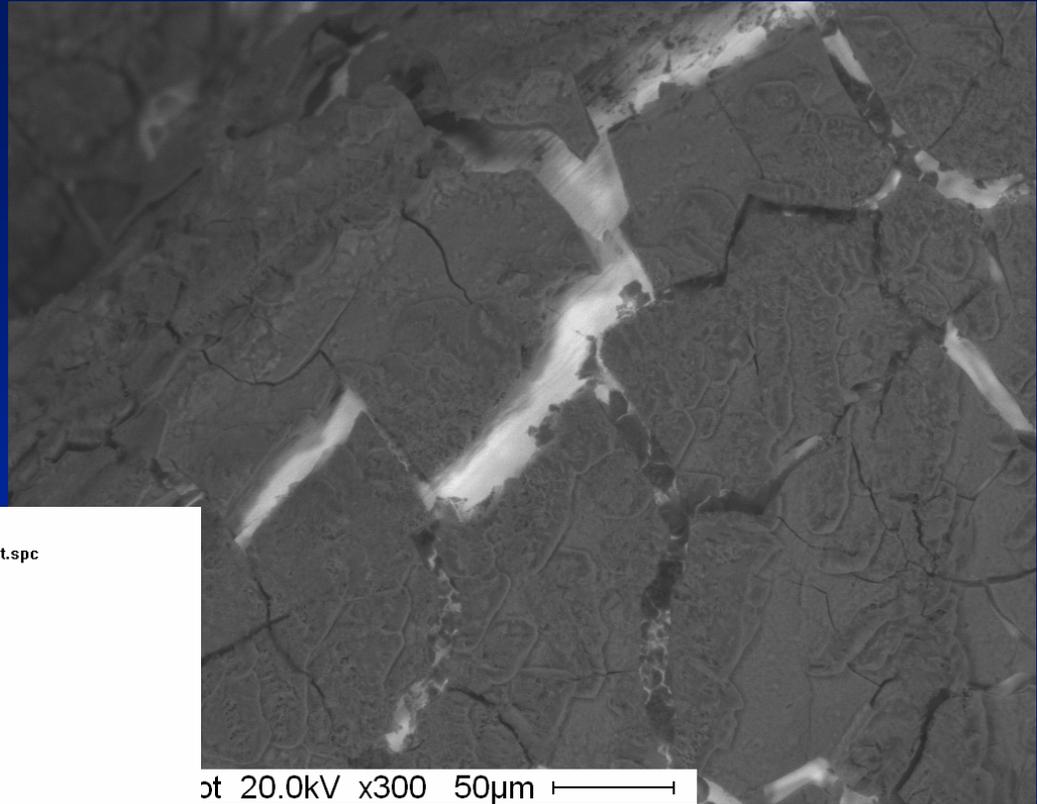


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Label A: section 2 west end middle-2

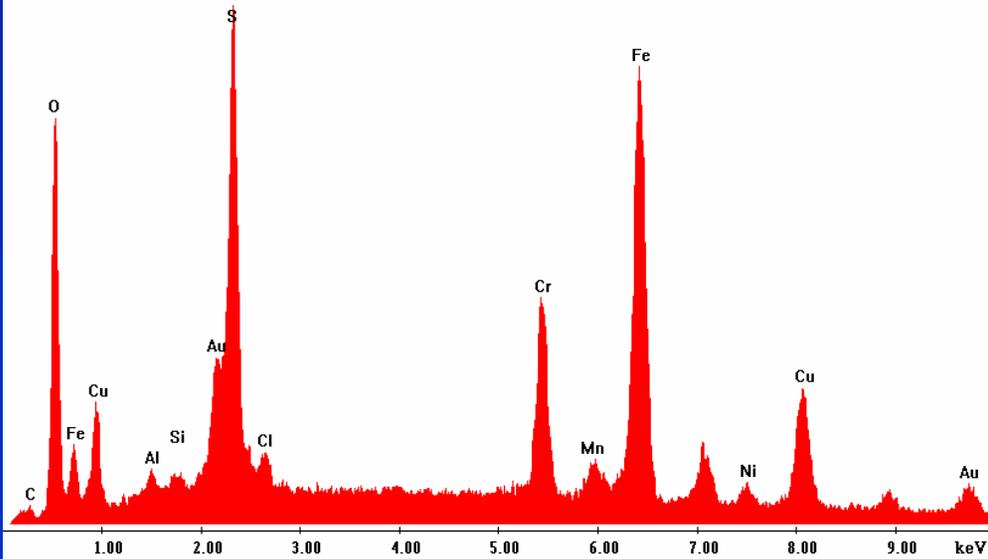


# SEM Analysis with EDS



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Label A: section 3 spot



# Results (New Substrates)

	Flow Rate	Gold Length	Inlet Hg	Outlet Hg		Normalized Removal
Date	(acfm)	(inches)	( $\mu\text{g}/\text{Nm}^3$ @3%O <sub>2</sub> )	( $\mu\text{g}/\text{Nm}^3$ @3%O <sub>2</sub> )	% Hg Removal	%/gold plate/acfm*10 <sup>6</sup>
7/13/2006	3600	36	3.61	3.08	15%	0.17
7/13/2006	2700	36	3.51	3.07	13%	0.19
7/14/2006	2700	36	4.23	3.88	8%	0.13
7/14/2006	1900	36	3.98	3.58	10%	0.22
7/14/2006	1300	36	3.98	3.61	9%	0.29
7/15/2006	1300	36	2.03	1.96	3%	0.11
7/15/2006	2700	36	4.23	4.11	3%	0.05
8/4/2006	2700	36	6.19	6.06	2%	0.03
8/18/2006	1300	12	3.53	3.30	6%	0.20
9/23/2006	2550	12	4.76	4.33	9%	0.15
9/24/2006	2700	12	2.53	2.26	11%	0.17
9/25/2006	2700	12	4.73	4.03	15%	0.23

# Summary – Plant Yates

- Initial Results indicate high level of mercury removal is possible
- Acidic conditions in flue gas corrode gold and stainless steel substrates
- Material build-up on gold surface inhibits mercury adsorption
  - Compounds include rust, gypsum fines, other sulfur oxides
  - Effect of flue gas flow rate not evident when plates are fouled
  - Wash system demonstrated improvement in mercury removal in short section of gold
- Ontario Hydro confirmed results seen with SCEMs

# GRE Stanton Station – FF/SDA Installation Background

- First Phase – SDA/FF Equipped Unit
- Host Unit - Great River Energy's Stanton Station Unit 10
- First substrates installed in August of 2003 in Clean Air Plenum of Baghouse Compartment 6
- Initial removal high (~70-90%), removal stabilized near 35 – 40%
- Results on North Dakota Lignite operation showed 3 months of service at 35 – 40% removal
- Results on PRB operation showed varied removal depending on gas temperature and lime/slurry feed to SDA
- Array removed from host unit in July of this year
- Over 22 months continuous gas treatment service time
- Additional evaluations and tests funded by Great River Energy and EPRI

# GRE Stanton Station – FF/SDA Installation

## Recent Work

- Geometry parametric testing
- Several geometry variations investigated including:
  - Varied length
  - Varied plate spacing
  - Varied orientation in flow
- Results indicate that removal does not directly correlate to active length
- Mass-Transfer not limiting
- Mechanism under investigation

# GRE Stanton Station – FF/SDA Installation

## Recent Work

Date	Description of Geometry/Duct	Removal (%)	Duct Temp (F)	Lime Feed (GPM)	Comments
4/25/2006	Duct 1 - 10' Active Length 1-inch Plate Spacing	39.2	202.8	21	2-day Average
	Duct 2 - Empty	0			
	Duct 3 - 40 Plates Perpendicular to Flow	4.7			
	Duct 4 - 8' Active Length, Alternate Material	9.7			
5/5/2006	Duct 1 - 10' Active Length 1-inch Plate Spacing	36.2	209.2	21.5	10-day Average
	Duct 2 - 8' Active Length, Alternate Material	0			
	Duct 3 - 5 Plates Perpendicular to Flow	7.4			
	Duct 4 - 4' Active Length 1-inch Plate Spacing	26.5			
7/7/2006	Duct 1 - 10' Active Length 1-inch Acid Washed	54.6	218.6	N/A	1-Day Average
	Duct 2 - 2' Active Length 1/2-inch Plate Spacing	56.5			
	Duct 3 - 2' Active Length 1-inch Plate Spacing	25.8			
	Duct 4 - 4' Active Length 1-inch Plate Spacing	30.6			

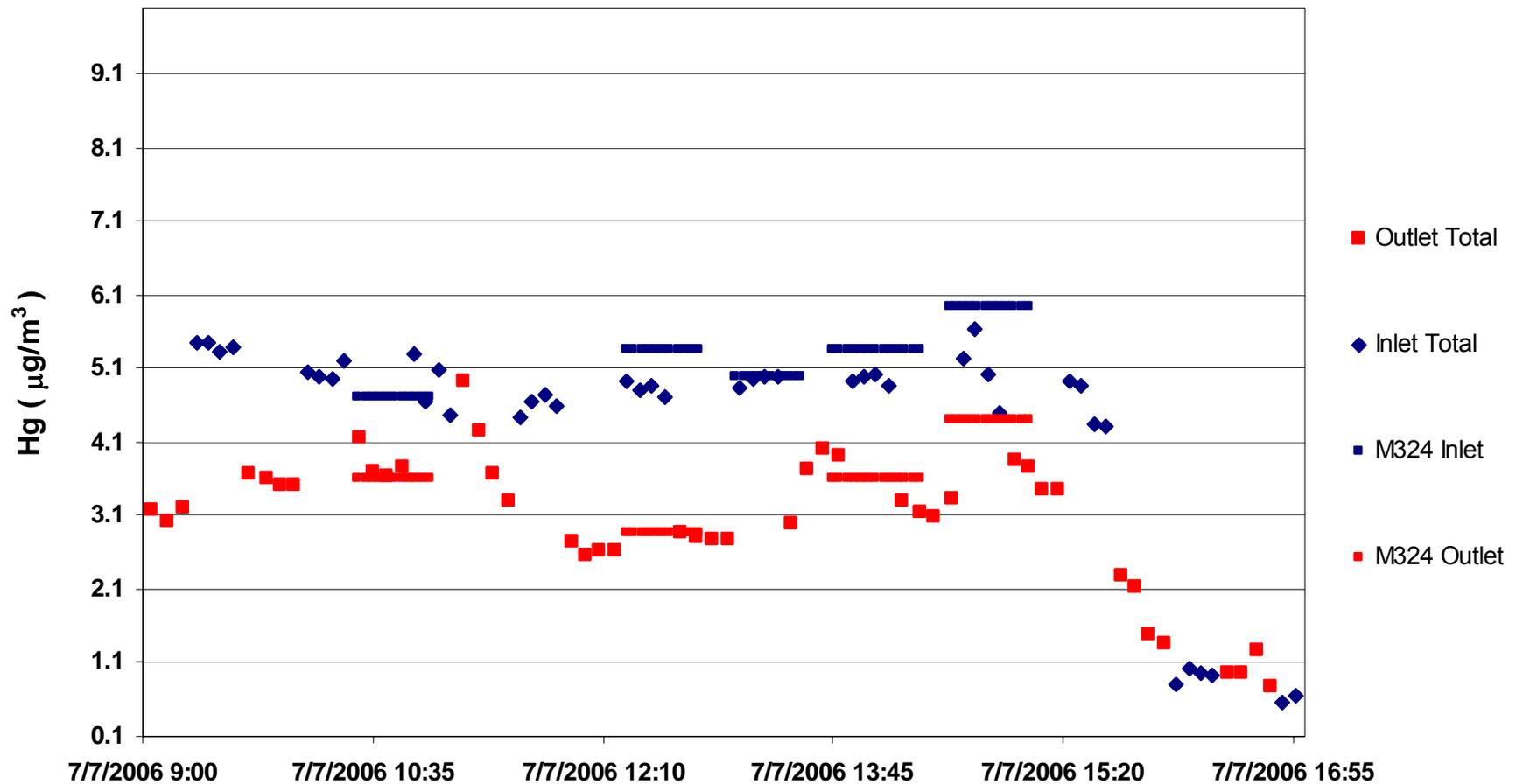
# GRE Stanton Station – FF/SDA Installation

## Recent Work

- 22nd Month of service time
- Method 324 Measurements conducted to verify Hg CEM results
- Removal remains variable depending on gas temperature and lime/slurry feed-rate
- 40 – 50% removal observed after nearly 2 years of continuous treatment service

Start Time	End Time	Trap ID	Inlet Hg (Trap)	Outlet Hg (Trap)	Trap Removal (%)	CEM Inlet	% Diff (inlet)	CEM Outlet	% Diff (outlet)	CEM Removal
7/7/2006 10:29	7/7/2006 10:59	2	4.72	3.59	24.01	4.98	-5.55	3.82	-6.47	23.34
7/7/2006 12:20	7/7/2006 12:50	3	5.36	2.87	46.50	4.83	9.97	2.85	0.85	41.08
7/7/2006 13:05	7/7/2006 13:30	4	5.00			4.94	1.10	3.00		
7/7/2006 13:45	7/7/2006 14:22	5	5.36	3.61	32.56	4.94	7.68	3.45	4.49	30.24
7/7/2006 14:33	7/7/2006 15:05	6	5.94	4.41	25.76	5.09	14.28	3.59	18.70	29.59

# GRE Stanton Station – FF/SDA Installation Recent Work



# GRE Stanton Station – FF/SDA Installation Conclusions

- MerCAP™ Array has been removed from the GRE Stanton Station Unit 10 Baghouse.
- Nearly 2 years of continuous service and gas treatment time without regeneration
- Six regeneration cycles demonstrated on single substrate
- Acid pretreatment of substrate material increases mercury capture performance
- Removal performance varies with gas temperature and limestone/slurry feed-rate to SDA
- Removal performance does not directly correlate to active length of sorbent structure
- Indications that mercury capture may not be mass-transfer limited
- Final analysis of gold substrates pending